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PARASITE COMMUNITIES IN EUROPEAN EELS *ANGUILLA ANGUILLA* (PISCES, TELEOSTEI) FROM A CORSICAN COASTAL POND

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ABSTRACT. – A parasite community study of the European eel (*Anguilla anguilla*) was realized in Urbino pond (Corsica). A preliminary description allows to distinguish five parasite species belonging to the two classes, Nematoda and Trematoda, and to note the absence of ectoparasites. A Principal Component Analysis (PCA) and a correlation analysis test highlight a positive correlation between the host size and the parasite number. This relation is true for studied parasites except for *Anguillicola crassus*. This Nematoda presents a negative correlation with host size, probably caused by food behaviour of the young eels. In our study, an opposition between Nematoda and Digenea also seems to occur. The parasite diversity of the eels from Urbino pond is weak. The parasite studies undertaken in other European lagoons and even in Corsica show higher parasitic loads and diversity.

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RÉSUMÉ. – Une étude de la communauté parasitaire de l'Anguille d'Europe (*Anguilla anguilla*) a été réalisée dans l'étang d'Urbino (Corse). Une description préliminaire permet de distinguer cinq espèces de parasites, appartenant à deux classes, Nématodes et Trématodes, et de constater l'absence d'ectoparasites. Une Analyse en Composantes Principales et un test de corrélation ont mis en évidence une corrélation positive entre la biométrie de l'hôte et la charge parasitaire. Cette relation est vraie pour les parasites étudiés sauf pour *Anguillicola crassus*. Ce Nématode présente une corrélation négative avec la taille de l'hôte, probablement due au comportement alimentaire des jeunes Anguilles. Dans notre étude, une opposition entre les Nématodes et les Trématodes semble aussi avoir lieu. La diversité parasitaire des Anguilles de l'étang d'Urbino est faible. Les études parasitaires menées dans d'autres lagunes d'Europe et même en Corse montrent des charges parasitaires et une diversité plus élevées.

INTRODUCTION

The European eels, *Anguilla anguilla*, are widespread and abundant in the ponds around the Mediterranean coast where they are usually fished at commercial purposes. This species is able to live in variable salinity environments (Kennedy *et al.* 1997). The eels are regarded as sedentary, they remain several years in the pond and are thus sensitive to the environmental quality (Bruslé 1989). The environmental conditions influence the composition of the parasite community. The parasite fauna of eels was studied in many localities (*e.g.* Di Cave *et al.* 2001, Kennedy 1993, 1997, Kennedy et *al.* 1997, 1998, Moravec 1985, Koie 1988, Schabuss *et al.* 1997, Sures *et al.* 1999, Sures & Streit 2001). To our knowledge, only one parasitic study on *Anguilla anguilla* was carried out on a pond of Corsica (Caillot *et al.* 1999). We decided to study eels from another pond: Urbino. The aim of this paper is to describe the parasite community, the species richness and the parasitic diversity of *Anguilla anguilla* from the Urbino pond. These features will be compared with those studied on other eel populations.

MATERIALS AND METHODS

The Urbino pond was selected for this study. This site is the second largest pond (760 ha) in Corsica (France), located on the eastern coast. The maximum depth is 12 meters (Agostini & Pergent-Martini 1997) and exchanges with the Tyrrhenean sea are permanents (Clanzig 1992). This pond is used for aquaculture and eels are regularly fished and marketed.

All samples were caught in fyke nets or traps by local fishermen. During April and June 2002, 31 fishes were brought back alive to the laboratory, measured, weighed and dissected. Stomach, intestine, liver, swimbladder, gills were examined for helminth and crustacean parasites. All metazoan parasites were fixed in 95% ethanol. For identification, Digenea were stained in a Carmin solution and mounted in Eukitt fluid. Nematoda were lightened in lactophenol solution. The parasite are classified according to Cable & Hunninen (1942), Moravec 1966, Petter & Radujkovic (1989), Radujkovic *et al.* (1989), and Taraschewski *et al.* 1987.

The terms prevalence, mean intensity and abundance were used as defined by Bush *et al.* (1997).

A test of correlation ($P < 0.05$) is carried out to show a relation between two variables which are in our study the number of parasites and the size of the eel (Schwartz 1963).

In order to give a representation of the structure of the parasite populations, a Principal Component Analysis (PCA) was used.

RESULTS

In Urbino pond, five parasite species were listed in European eels. Two Digenea, *Deropristis inflata* Molin, 1958 and *Lecithochirium musculus* Looss, 1907, and three Nematoda, *Anguillicola crassus* Kuwahara, Niimi et Itagaki, 1974, *Hysterothylacium aduncum* Rudolphi, 1802 and *Paraquimperia tennerima* (Baylis, 1934) are present (Table I).

All these parasites are helminths. *D. inflata*, *L. musculus*, *P. tennerima* have wide habitats. They infest the stomach and the intestine. Conversely, *H. aduncum* and *A. crassus* have restricted habitats. They are specific of a single organ. *H. aduncum* is present in the intestine and *A. crassus* parasitizes the swimbladder.

No ectoparasite was observed on the gills, in the oral cavity and on the skin.

Out of 31 studied eels, only five are devoid of parasites. 84% of fish are, thus, parasitized by at least one species of parasite (Table I).

The Digenea are the dominant group of helminths, their prevalence is 81%. *D. inflata*, an eel specialist, is the parasite most frequently met (prevalence of 81%). It is dominant in the stomach as in the intestine. The mean intensity of this Digenea varies from 14 in the intestine to 8.5 in the stomach. *L. musculus* is the second species most observed even if its total prevalence is only 26%. Contrary to *D. inflata*, *L. musculus* presents a more significant prevalence in the stomach than in the intestine.

The Nematoda are less represented than the Digenea, their prevalence is only 26%. *A. crassus*, swimbladder parasite, is one of the most frequent Nematoda. Its prevalence is 13% and its mean intensity 1.25. *P. tennerima* has a prevalence of 13%. Its parasitic indices are low but more significant in the intestine than in the stomach. The last listed Nematoda, *H. aduncum*, is present only in two individuals at the level of the intestine.

The Principal Component Analysis (PCA) gives indications on factors related to parasite distribution (Fig. 1). The biometric variables of the host are correlated with the factorial axis 1. It comes out from this multivariate analysis a positive association between the biometric parameters (size, weight, weight of the liver) and the number of parasites. This result is confirmed besides by a test of correlation ($R = 0.86$, $P = 0.05$).

The Digenea, *D. inflata*, is the parasite more influenced by biometric parameters of eel. The bigger the host is, the more the number of *D. inflata* is significant in the stomach as in the intestine. *L. musculus* seems also related to the biometric variables of eel even if this relation abundance/biometric variables is less visible than that of *D. inflata*.

Table I. – Site, prevalence, abundance and mean intensity of the parasite species of 31 eels from the pond of Urbino. I = intestine, S = stomach, SW = swimbladder, SE = standard error

Species		Site	Prevalence %	Abundance ± SE	Mean Intensity ± SE
Digenea			80.64		
F. Acanthocolpidae	*Deropristis inflata*	I	70	9.45±1.96	13.95±3
		S	53	4.39±1.12	8.5±2.12
F. Hemiuridae	*Lecithochirium musculus*	I	9.67	0.39±0.22	4±2.31
		S	20	0.58±0.23	3±1.22
Nematoda			25.80		
F. Anguillicolidae	*Anguillicola crassus*	SW	13.33	0.16±0.08	1.25±0.62
F. Quimperiidae	*Paraquimperia tennerima*	I	6.45	0.3±0.1	2±1.41
		S	6.45	0.1±0.07	1.5±1.1
F. Anisakidae	*Hysterothylacium aduncum*	S	6.45	0.06±0.05	1±0.7

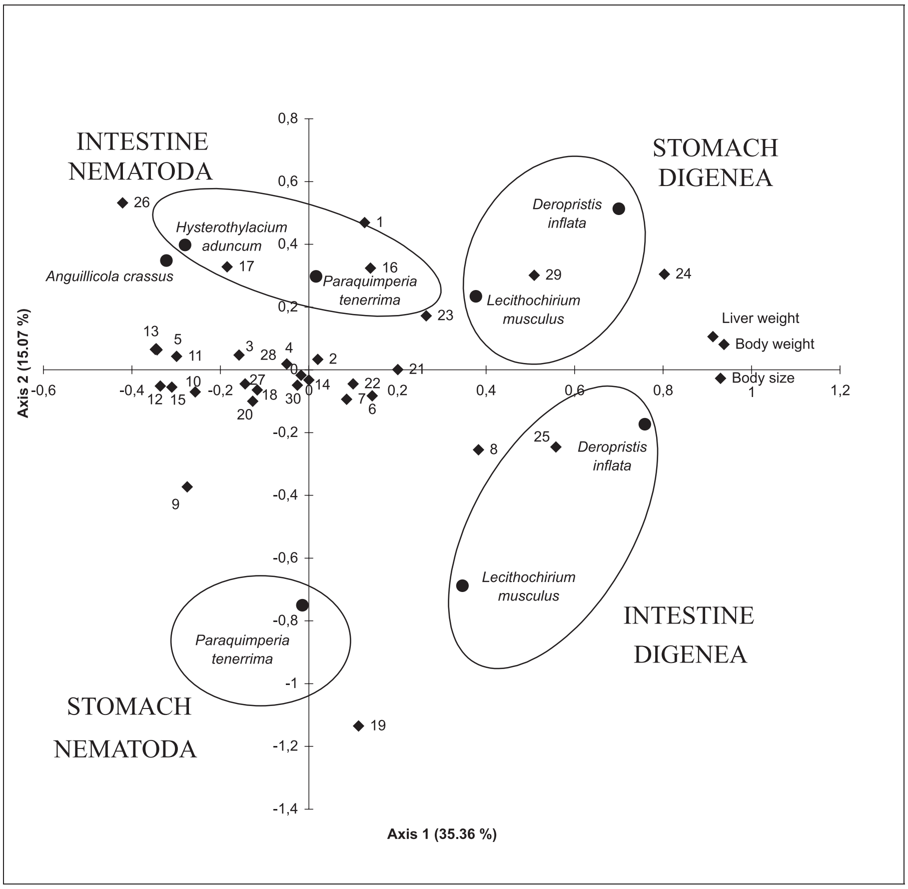

Fig. 1. – Principal Component Analysis of *Anguilla anguilla* from Urbino pond.

The Nematoda are not or little subjected to the influence of the size and the weight of the host. *A. crassus* and *H. aduncum* are correlated negatively with the biometric parameters of *A. anguilla*.

The PCA also states to us that the presence of *D. inflata* and that of *L. musculus* seem dependent. This last, indeed, is listed only when *D. inflata* is represented. For each organ, an opposition between the Nematoda and the Digenea occurs.

DISCUSSION

The study of the parasitic fauna of A. *anguilla* in Urbino pond is characterized by the absence of certain parasites. Indeed, the Copepoda, Monogenea, Acanthocephala and Cestoda do not parasitize any of the 31 analyzed eels.

The parasitic community of this pond is quite distinct from that studied in the nearby pond of Biguglia (Corsica, France). Caillot *et al.* (1999) has reported five parasitic groups in 20 European eels from Bigulia pond during April and June 1997. *Ergasilus gibbus* (Copepoda), *Pseudodactylogyrus anguilla* (Monogenea), *Bothriocephalus claviceps* (Cestoda) are present in eels. The absence of these species in Urbino can be related to various factors. The abiotic variables like the salinity or the water temperature influence the installation of certain parasites. Indeed, *Ergasilus gibbus* is a copepod specific of the environment with low salinity and high water temperature (Raibaut & Altunel 1976). However, Urbino is a pond which does not meet these conditions. The salinity of the pond rarely goes down below 30‰ and the water temperature is low because of its depth and of marine influences (Agostini & Pergent-Martini 1997). In Biguglia, the environmental conditions are different: area (1500 ha), maximum depth (2m), salinity (5-21‰) (Agostini & Pergent-Martini 1997). The human activities can influence the fauna of the two ponds. In Urbino, the sea-farming are developed contrary to Biguglia. Nevertheless, the fish biodiversity is similar in the two ponds (Agostini & Pergent-Martini 1997).

The absence of intermediate hosts could also explain the absence of these parasites. The intermediate hosts, *Macrocyclops albitus* or *Acanthocyclops robustus* (Dupond & Gabrion 1987), or paratenic hosts (fishes) (Morand *et al.* 1995), of *B. claviceps* would not be present in Urbino pond which would involve the absence of the Cestoda.

P. anguillae, parasite with a direct cycle, is an allochtone species (Buchmann *et al.* 1987) which would not have been introduced yet into this pond.

Conversely, the Nematoda *P. tenerrima* and *H. aduncum* are listed only in Urbino. In the same way, their presence in Urbino can be related to that of their intermediate hosts which would be absent or not enough abundant in the Biguglia pond.

The parasites common to both ponds are the Digenea *D. inflata* and the Nematoda *A. crassus*. Parasitic indices of *D. inflata*, eel specialist (Di Cave *et al.* 2001), are important in the two ponds. *A. crassus* is not very abundant in Urbino. This species, originating from the south east of Asia (Kuwahara *et al.* 1974), was introduced in Europe by the Japanese eel importation (Dupond & Petter 1988). *A. crassus* is very widespread throughout Europe (Moravec 1992). Indeed, it does not show preference for a specific habitat (Taraschewski *et al.* 1987) since 10 species of Cyclopoida are known to be its intermediate hosts (De Charleroy *et al.* 1990). In Urbino pond, the prevalence of this Nematoda is low and less significant than in Biguglia. Its arrival in the pond could thus be later than its colonization of Biguglia pond.

A negative correlation between the host size variables and the number of *A. crassus* was shown in Urbino pond. The smallest eels, therefore young eels, are more parasitized by *A. crassus*. However, in reality, the small eels like largest ones can be infested by *A. crassus* (De Charleroy *et al.* 1990). The food behaviour of eels could explain why the young eels are more parasitized than older eels. The young eels have a diet primarily made up of the Copepoda (Lecomte-Finiger 1983) which are the intermediate hosts of A. *crassus*, while the old eels are piscivorous (Tesch 1977). However, in Urbino pond, the largest eels present none *A. crassus*. In this particular case, the presence of the Nematoda in the swimbladder would involve a significant mortality of eels, which would explain why only the young eels are parasitized. This assumption is in favour of a recent introduction of *A. crassus* in Urbino. Indeed, it was already often shown that the introduction of a parasite into a new biotope can involve such mortalities (e.g. Molnár *et al.* 1991).

Generally, the containment of Biguglia pond and its biodiversity allow a circulation of the parasites more significant than in Urbino pond.

The eels of Urbino as those of Biguglia have a parasitic diversity lower than those studied in many European areas. Acanthocephala and Cestoda are absent in *A. anguilla* from Urbino. These two groups however are frequently found in eel in Germany (Sures *et al.* 1999, Sures & Streit 2001), in England (Kennedy 1993, 1997), in Belgium (Schabuss *et al.* 1997), in Denmark (Koie 1988), in Italy (Di Cave *et al.* 2001, Kennedy *et al.* 1997, 1998) and in Czechoslovakia (Moravec 1985, Seyda 1973). In Urbino, the Nematoda are represented only by three species. Certain areas like the lake Esrum in Denmark (Koie 1988) have an eel population presenting three times more species of Nematoda. Other parasitic studies in eel reveal an omnipresence of Monogenea, ectoparasites absent from Urbino pond (Caillot *et al.* 1999, Di Cave *et al.* 2001, Kennedy *et al.* 1997, 1998, Koie 1988, Sures *et al.* 1999, Sures & Streit 2001).

The relation between the parasitic abundance of some taxa and the host size parameters was already shown in other fish species (Gonzalez & Acuna 2000, Poulin & Rohde 1997, Rohde 1995) and in the eel (Taraschewski *et al.* 1987, Buchmann 1989). The parasitic loads increase with the age and thus with the eel size. The older the host is, the more time increases the probability of acquiring new species of parasites (Lo *et al.* 1998). The diet has also a dominant role in parasitic abundance. The old individuals, more imposing physically, have more significant energy needs. They eat more and increase their probability of being infested by ingestion. The benthic invertebrates and the small fish constitute the diet of eel. For example, the Trematoda of *A. anguilla* are well represented since they use Gasteropoda as intermediate hosts (Rohde 1993).

In this study, an opposition between the Nematoda and the Digenea of the digestive tract is highlighted. *A. anguilla* presents a limited number of vacant niches, the parasites select certain sites in order to avoid the competition (Kennedy 1985). However, the parasite species can be in competition for space (niches) and for the resources (Kennedy & Moriarty 1987, Bates & Kennedy 1990, Kennedy 1992). In eels of Urbino pond, there is a competition between the Nematoda and the Digenea of the digestive tract. The Digenea, which have strong prevalence, dominate the Nematoda slightly represented. In the same way, the Digenea species of the intestine and the stomach can be in competition. *D. inflata* would be then the dominant species of the digestive tract since its prevalence is clearly higher than that of the Digenea *L. musculus* and than that of the Nematoda *P. tenerrima* and *H. aduncum*.

The study of the parasitic fauna of eels from Urbino pond enabled us to highlight a low diversity and parasitic loads relatively low. Parasite exclusions and a relation between host size and parasitic abundance are observed. The parasite community presents particular features and this difference is marked by the absence of ectoparasites (the Copepoda and the Monogena). Other studies concerning the parasitic community of A. *anguilla* in Urbino pond will be necessary to precisely describe the composition of this parasitic fauna.

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